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ABSTRACT

A. Wigfield and J. Meece (1988) developed the Mathematics Anxiety Questionnaire (MAQ) to measure the cognitive and affective aspects of mathematics anxiety. In particular, using school-aged students, Wigfield and Meece have provided evidence that the MAQ measures two factors identified as Worry and Negative Affective Reactions. This study used responses of 35 male and 173 female college students in a 2-group simultaneous confirmatory factor analysis to see if the 2-factor model for the MAW held for both males and females. The results of the confirmatory factor analysis indicate that the two-factor model is adequate for male and female college-aged samples and that the factor pattern is invariant across the genders. (Contains 3 tables and 12 references.) (SLD)

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The Math Anxiety Questionnaire: A Simultaneous Confirmatory Factor Analysis Across Gender

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Abstract

Wigfield and Meece (1988) developed the Mathematics Anxiety Questionnaire (MAQ) to measure the cognitive and affective aspects of mathematics anxiety. In particular, using school-aged students Wigfield and Meece have provided evidence that the MAQ measures two factors identified as Worry and Negative Affective Reactions.

The present study used responses of 135 males and 173 females in a two-group simultaneous confirmatory factor analysis to see if the two factor model for the MAQ held for both male and female college-aged students. The results of the confirmatory analysis indicated that (a) the two factor model was adequate for male and female college-aged samples, and (b) the factor pattern was invariant across the genders.

The Mathematics Anxiety Questionnaire: A Simultaneous Confirmatory Factor Analysis Across Gender

Liebert and Morris (1967) in their work on test anxiety distinguished between the cognitive and the affective components of anxiety. The cognitive component of anxiety consisted of self-deprecating thoughts about one's performance, and the affective component included the physiological reactions to situations and feelings of nervousness and tension. Following this conceptualization of anxiety, Wigfield and Meece (1988) developed the Math Anxiety Questionnaire (MAQ) to explore the cognitive and affective components of mathematics anxiety.

The MAQ was developed in several stages. The original instrument was designed to measure six dimensions of negative reactions to mathematics. Extensive item analysis and both exploratory and confirmatory factor analyses using students in the 5th-12th grades resulted in an 11 item questionnaire measuring two factors identified as negative affective reactions and worry. The negative affective reactions dimension assessed nervousness, uneasiness, and dread when working mathematics, and the worry dimension assessed the degree of worry about how one is doing in mathematics.

Wigfield and Meece (1988) reported a statistically significant ($p < .001$) gender effect for scores on the negative affective reactions scale and a statistically significant ($p < .01$) grade level by gender interaction for the worry scale raising some concern about gender differences on the two dimensions. The issue of gender differences in the area of mathematics anxiety is unclear. Brush (1978), Betz (1978), Dew, Galassi, and Galassi (1983), and D'Ailly and Bergering (1992)

all reported gender differences in mathematics anxiety scores. However, Resnick, Viehe, and Segal (1982), Hyde, Fennema, Ryan, Frost and Hopp (1990), and Dwinell and Higbee (1991) found no gender differences.

It is unclear as to whether the factors found by Wigfield and Meece (1988) using school-aged students would hold for a college-aged population. It is also unclear as to whether the same factors would hold for male and female respondents. Therefore, the present study addressed three questions (1) do the two factors of negative affective reactions and worry found by Wigfield and Meece (1988) using 5th-12th grade students hold for a college age population, (2) do these same factors hold for males and females in the college age population, and (3) do the same factor parameters fit both groups

To answer these questions, a two-group simultaneous confirmatory factor analysis was carried out (Joreskog, 1971; Lomax, 1983). A two step analytic approach was planned. A multi-group simultaneous confirmatory factor analysis is a two step analytic approach. At step one it is determined if the same factor model holds for each group. If the same factor model is accepted for the groups, the second step is carried out to determine if the model parameters are the same for each group.

Methodology

Sample

The sample consisted of 177 female and 143 male undergraduates from a university in the Southeast enrolled in a required freshman level algebra course. Approximately 70% of the sample were Caucasian and about 25% were African-American. The ages of the sample ranged from 17 to the early 50's. All subjects were volunteers and received extra credit for participation

in the study. All students in the classes agreed to participate.

MAQ

The Math Anxjety Questionnaire (MAQ) consists of eleven items designed to measure the cognitive and affective dimensions of mathematics anxiety (Wigfield & Meece, 1988). Exploratory and confirmatory factor analyses of the MAQ using a sample of 5th through 12th grade students resulted in two factors identified as negative affective reactions and worry about doing well in mathematics. The negative affective reactions scale consisted of seven items, and the worry scale consisted of four items. Alpha coefficients of .76 for the worry sacle and .80 for the negative affective reactions scale were found (Wigfield & Meece, 1988).

Analysis

A simultaneous confirmatory factor analysis was used to determine if the same factor model would hold for both the female and male college students. Potentially, two separate analysis models could be examined. Model A tested to see if the same factor model held for both groups. If model A was accepted, then model B would be employed to determine if the same model parameters held for the two groups. The program AMOS 3.61 was used to evaluate the models.

Procedures

The MAQ was administered as part of a larger battery of instruments. Data were collected over a two semester period using students in five separate college algebra classes. Data were collected during a single class period. Students were awarded extra credit points for participation in the study. Participation was voluntary, however, all students agreed to participate.

Results

As a preliminary step a multivariate comparison of the mean responses of the male and female respondents was carried out. The multivariate F-ratio based on Wilks' lambda was statistically significant ($F(22, 590) = 1.98$, $p < .01$). Cohen's (1988) effect size measure indicated the effect size to be in the moderate range ($f^2 = .15$). For the individual items, statistically significant differences ($p < .05$) in the two groups were found on eight of the eleven items. Associated effect size measures using Cohen's (1988) d statistic indicated that the differences were relatively small ($d = .20$'s) for three of the items, however, the remaining effect sizes hovered around the medium effect size level (Table 1). The presence of mean level differences across the items suggest that the two genders should not be combined for a factor analysis in that the mean level differences can attenuate correlations between the items (Kirk, 1990).

The first step in the two-group simultaneous confirmatory factor analysis was to create a two-factor model with Worry and Negative Affective Reactions as defined by Wigfield and Meece as oblique factors. This model is identified as Model A. The unstandardized maximum-likelihood parameter estimates are presented in Table 2. All item loading parameters exceeded the associated standard errors by more than 2.0 for both the male and female samples indicating substantial loadings for each item on their designated factors. Selected goodness-of-fit measures are provided in Table 3. The goodness-of-fit Chi-square was 254.57 which based on 86 degrees of freedom has an associated probability of less than .001. The chi-square value, the GFI of .870, and the adjusted GFI of .800 suggest the model fit to be less than ideal. However, the ratio of chi-square to degrees of freedom of 2.96 and the root mean square error of approximation (RMSEA) of .080 each suggest acceptable model fit (Browne & Cudeck, 1993;Carmines & .

McIver, 1981; Kline, 1998; Marsh & Hocevar, 1985). Although the goodness-of-fit measures are not in total agreement concerning the model fit, the fit was judged to be adequate. This suggests that the two factor model is appropriate for the male and female samples.

In that the fit of Model A was deemed acceptable, the second model (Model B) requiring equal factor coefficients for the males and females was tested. The resulting parameter estimates are provided in Table 2. The factors were found to be moderately correlated (.587). The associated goodness-of-fit measures for Model B are presented in Table 3. As with Model A, there is no consensus among the goodness-of-fit measures. The chi-square value is still large (263.45) and with 95 degrees of freedom has an associated probability less than .001. Likewise, the GFI and adjusted GFI are each less than .90. However, the ratio of the chi-square to degrees of freedom is 2.77 and the RMSEA is .076 each indicated adequate model fit.

The difference in the Model A and Model B chi-squares is small at 8.88 and with 9 degrees of freedom has an associated probability which is greater than .05 (Table 3). This small change in chi-square values suggests that the additional constraint of equal factor coefficients resulted in little change in model fit. Thus the group-invariant factor pattern of Model B is further supported.

Discussion

The two MAQ factors of Worry and Negative Affective Reaction factors reported by Wigfield and Meese (1988) using a sample of school-age respondents were found to hold for the college-age respondents used in the present study. Furthermore, the factors held for both male and female college-age respondents. Also, the factor patterns for the present sample were found to be invariant across gender. The two Wigfield and Meese two-factor model appears to be quite

robust across both age and gender.

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Table 1

Comparison of Mean Item Responses of Males and Females

	Females			Males				
Item	Mean	S.D.	N	Mean	S.D.	N	t	d
1	3.78	1.80	177	4.03	2.00	143	1.20	.135
2	4.86	1.72	177	4.93	1.89	143	0.33	.037
3	3.95	1.75	176	4.29	1.93	142	1.62	.182
4	3.37	1.88	177	3.82	1.81	143	2.17*	.244
5	3.25	1.81	177	4.08	1.87	141	3.97***	.448
6	3.54	2.03	177	3.99	2.02	142	1.98*	.224
7	4.23	2.07	176	4.75	1.91	143	2.31*	.261
8	2.39	1.73	176	2.99	1.97	142	2.92**	.329
9	2.49	1.73	177	3.46	1.85	141	4.84***	.547
10	2.56	1.65	177	3.22	1.88	142	3.33**	.376
11	3.03	1.79	177	3.59	1.95	142	2.66**	.299

* $p < .05$

** $p < .01$

*** $p < .001$

Table 2

Unstandardized Parameter Estimates and Associated Standard Errors for Model A and Model B

Parameter	Model A				Model B			
	Females		Males		Females		Males	
Parameter	Estimate	S. E.	Estimate	S. E.	Estimate	S. E.	Estimate	S. E.
I2 ← NA*	1.12	0.19	0.97	0.19	1.04	0.13	1.04	0.13
I3 ← NA	-0.91	0.18	-0.49	0.17	-0.73	0.12	-0.73	0.12
I4 ← NA	0.94	0.18	1.04	0.19	0.99	0.13	0.99	0.13
I5 ← NA	1.44	0.21	1.42	0.22	1.44	0.15	1.44	0.15
I6 ← NA	1.54	0.22	1.34	0.21	1.44	0.15	1.44	0.15
I7 ← NA	1.31	0.20	1.24	0.22	1.27	0.14	1.27	0.14
I9 ← W*	1.19	0.12	1.11	0.16	1.16	0.10	1.16	0.10
I10 ← W	1.37	0.13	1.42	0.18	1.39	0.11	1.39	0.11
I11 ← W	0.93	0.12	1.21	0.17	1.06	0.10	1.06	0.10
NA ↔ W	0.21	0.05	0.25	0.06	0.22	0.04	0.25	.050
Var(NA)	0.29	0.08	0.32	0.10	0.31	0.07	0.30	0.07
Var(W)	0.47	0.10	0.41	0.10	0.46	0.08	0.43	0.08
Var(e1)	0.71	0.08	0.68	0.09	0.70	0.08	0.68	0.09
Var(e2)	0.64	0.08	0.70	0.09	0.65	0.08	0.69	0.09
Var(e3)	0.76	0.09	0.92	0.11	0.78	0.09	0.92	0.12
Var(e4)	0.74	0.08	0.65	0.09	0.73	0.08	0.67	0.09
Var(e5)	0.39	0.06	0.35	0.06	0.38	0.05	0.36	0.06
Var(e6)	0.31	0.05	0.42	0.07	0.32	0.05	0.42	0.07
Var(e7)	0.50	0.06	0.51	0.07	0.51	0.06	0.50	0.07
Var(e8)	0.53	0.06	0.60	0.08	0.53	0.06	0.59	0.08
Var(e9)	0.33	0.05	0.50	0.07	0.34	0.05	0.49	0.07
Var(e10)	0.12	0.04	0.18	0.05	0.12	0.04	0.18	0.05
Var(e11)	0.59	0.07	0.41	0.06	0.58	0.07	0.44	0.06

*NA = Negative Affect Reaction, W = Worry

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Table 3

Results of Tests of Goodness-of-Fit

Model	Chi-Square	df	p	Chi-sqr/df	RMSEA	GFI	AGFI
A	254.57	86	< .001	2.96	.080	.870	.800
B	263.45	95	< .001	2.77	.076	.864	.811
diff	8.88	9	ns				